The reliability of measurements with the spinal mouse device in frontal and sagittal planes in asymptomatic female adolescents

The reliability of measurements with the spinal mouse device

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Abstract

Aim: The aim of this study is to investigate the reliability of the Spinal Mouse device in both frontal and sagittal measurements in asymptomatic female adolescents. Material and Method: A total of 28 female students aged 15-18 (16.29 ± 1.08) in high school equivalent education institutions in Antalya were included in the study. Measurements were performed with the Spinal Mouse device in both frontal and sagittal planes with a one-week interval. The reliability of the two measurements was evaluated using the intraclass correlation coefficient (ICC). Results: In this study, the test-retest results of the thoracic and lumbar region measurement in the frontal plane were found to be moderately reliable (ICC: 0.591-0.665), and the test-retest results of the thoracic and lumbar region in the sagittal plane showed good reliability (ICC: 0.867-0.876). Discussion: In this study, the test-retest results of the thoracic and lumbar region measurements in the frontal plane were found to be moderately reliable. The test-retest results of the thoracic and lumber curves in the sagittal plane showed good reliability. In the light of these data, we believe that, if the application principles of the device are implied carefully, the Spinal Mouse device is a practical and reliable device that can be used by physiotherapists in field screening and in clinical assessment of spine problems.

Keywords

Spinal Mouse; Scoliosis; Frontal; Sagittal; Reliability; Spine

Introduction

The three-dimensional deviation of the vertebral column greater than 10 degrees in the frontal plane is referred to as scoliosis. Adolescent idiopathic scoliosis (AIS) is a spinal deformity seen in 2.5% of the population. In literature, it has been reported that scoliosis is seen in 2-4% of children aged between 10 and 16 years. Progressive scoliosis can lead to deformities and cosmetic problems [1,2]. In adolescents, considering the effects of heavy school bags on the musculoskeletal system, it is better understood that regular screening in schools is important in the diagnosis and treatment of scoliosis [3]. Measuring the Cobb angle is the most commonly used method in the diagnosis of scoliosis [4]. Although there are methods of evaluation with low-dose radiation such as the EOS 2D / 3D vector analysis systems, the Cobb angle is still the most valid method of measurement. The progression of AIS is usually rapid, therefore, patients with AIS should be assessed routinely and often. Consequently, patients are frequently exposed to radiation in order to measure the Cobb angle [5,6,7,8,9]. This situation has led researchers to seek different assessment methods that do not emit radiation. The inclinometer, flexiruler, goniometer, kyphometer, ultrasound and other computer-assisted systems are some of the leading non-invasive and radiation-free methods [10,11,12].

The Spinal Mouse is a non-invasive device that measures the curvatures of the vertebral column in the frontal and sagittal planes [13,14]. It can give detailed information about the positions of each vertebra, as well as their position relative to each other, without generating any medical risks or emitting radiation. The data obtained is transferred instantly to the computer which connects to the device via Bluetooth connection. The obtained data can be easily interpreted using the Spinal Mouse software.

Validity and reliability studies of the spinal mouse are present in literature; however, it is noteworthy that studies on the reliability of the measurements in the sagittal plane are limited. Therefore, the aim of this study is to investigate the reliability of the Spinal Mouse device in both frontal and sagittal measurements in asymptomatic female adolescents.

Material and Methods

Twenty-eight asymptomatic female students aged 15-18 (16.29 ± 1.08) who are being studied at high school equivalent education institutions in Antalya were included in the study (Table 1). Those who; had pain in the back and lumbar region in the past 3 months, those who had undergone surgery in these regions and those who had a body mass index (BMI) of 30 and above were excluded from the study.

Before the study, necessary permits were obtained from the district governorate, the national education directorate, the parents and the participating students. All of the parents and students were informed in detail about the procedures to be carried out. The necessary Ethical approval was obtained from University (document date and number: 11/10/2018-E.136654). The measurements were performed by an experienced physiotherapist who had previously used the device. The body weights of the participants were measured using the Baurer bf-100 device (Manufacturer: Beurer GmbH Servicecenter Lessingstraße 10 b 89231 Neu-Ulm, Germany). The Spinal Mouse (Manufacturer: IdiagAG Mülistrasse 18 CH-8320 Fehraltorf, Switzerland) measurements were performed at a sampling rate of approximately 150 Hz at every 1.3 mm. Before the measurements were performed, the procedures regarding the measurements were explained and demonstrated to the participants. The measurements were taken with the Spinal Mouse in frontal and sagittal planes and were repeated by the same physiotherapist following exactly a one-week interval. In order to carry out the measurements in the frontal plane, the participants were asked to stand in a comfortable posture in standing position. The first measurement was completed by guiding the device at a constant speed over the spinous processes of the c7-s5 which were previously marked by the physiotherapist. Measurements in the sagittal plane were also measured from the marked area, as in the frontal plane. All measurements were recorded on a computer which had Spinal Mouse software. The recorded data were analyzed using the Spinal Mouse program and angular deviations between each vertebra were determined in both the sagittal and frontal plane. Additionally, segmental results were also reported by the program software (total scores of thoracal and lumbar regions). In this study, the results of the thoracic and lumbar region during upright position calculated by the Spinal Mouse's original software (Idiag AG) were taken into consideration.

Statistical analysis

We evaluated the test re-test reliabilities with the intraclass correlation coefficient (ICC). The ICC values were graded from low reliability to high reliability between 0 and 1. Accordingly, ICC values were classified as 0.75<= good, 0.50-0.74 = moderate and 0.5>= poor [15].

Results

The demographic characteristics of the participants are shown in Table 1. The test-retest results of the thoracic and lumbar region measurements were found to be moderately reliable in the frontal plane and a good reliability was found in the sagittal plane according to the ICC values (Table 2).

Table 1. Demographic characteristics of participants

Characteristics	Mean±sd (n=28)
Age	16.29±1.08
Weight	57.61±8.93
Height	164.96±7.15
BMI (kg/m^2)	21.14±2.88

Table 2. ICC Values

	ICC
Thoracal curve in frontal	0.665
Lumbal curve in frontal	0.591
Thoracal curve in sagital	0.867
Lumbal curve in sagital	0.876

Discussion

In this study, the reliability of the Spinal Mouse, which is a radiation-free device used frequently for clinical assesment of vertebral column in the last 10 years, was evaluated using ICC. As a result of this study, in adolescents with no defined musculoskeletal pathology who were between 15-18 ages; it was found that the Spinal Mouse device had good reliability in the measurements in the sagittal plane and moderate reliability in the measurements in the frontal plane.

It is known that the gold standard assessment method for the posture and range of motion (ROM) of the vertebral column is the X-Ray [14]. However, in situations such as AIS which require frequent radiologic assessments, clinicians are concerned on the negative effects of radiation, such as cancer [15]. This has led clinicians and researchers to seek new methods that are radiation-free, such as the Spinal Mouse. The Spinal Mouse device is a practical device that was created in the early 2000s as a result of these researches. The Spinal Mouse is guided through the spinous processes at a constant speed and transmits the data collected at every 1.3 mm to the computer at a sampling rate of approximately 150 Hz. The device provides information on the segmental and regional (thoracic and lumbar) position and mobility of the spine in the frontal and sagittal planes. Additionally, it also provides information on; the amount of inclination of the trunk to the left, right, back or front, the hip joint mobility and also about the length of the spine. The device records the movements in three planes in space by means of a gyroscope and transfers them to the computer via Bluetooth. The specific algorithm of the Spinal Mouse software makes the data obtained from the information obtained on the position of the vertebral column meaningful by interpreting this information on the computer. In the measurements performed in the frontal plane, the algorithm obtains the segmental angulation between two vertebrae accordingly; two vectors are drawn, one parallel to the top of the upper vertebra and the other parallel to the bottom of the lower vertebra. The result is obtained from the angular information obtained from the intersection of these two vectors in space. In the sagittal plane, the segmental angulation is also obtained from intersection of the two vectors of the upper and lower vertebrae. With the intersection of these two vectors, the segmental angle information in the vertical plane is obtained. Regional results are obtained from the combination of information from each segment (Thoracic and lumbar). With these regional results, comments can be made about the angular values of scoliosis, kyphosis or lordosis and progression can be followed in cases such as AIS.

In literature, there are few studies investigating the reliability of the Spinal Mouse device. In 2008, Kellis et al. performed measurements with the Spinal Mouse in the sagittal plane in 81 healthy boys aged between 8 and 12 years with three investigators who had never used the SM device before. Measurements were repeated 2 times. As a result of the measurements, parallel with our results, the Spinal Mouse device was found to be a reliable method in the assessment of the sagittal plane (Intraobserver ICC 0,61-0,96) [16]. In 2004 Mannion et al. measured segmental and total joint range of motion with a Spinal Mouse device on 20 healthy adult volunteers [13]. The measurements were performed on different days. 2 researchers performed 3 measurements in total and the ICC value was between 0.82 and 0.86. In the light of these results, Mannion et al. suggested that the device could be used for clinical data collection, and suggested further studies with larger groups in different regions and different ages. In the study performed by Ö Buyukturan et al., in 2018, the Spinal Mouse was found to be valid and reliable in the measurements of thoracic kyphosis and lumbar lordosis made in the sagittal plane in an asymptomatic geriatric group (68,12 ± 2,67 y) of 46 individuals (29 females and 17 males). However, they did not assess the reliability of frontal plane measurements on geriatrics [17]. Together with chronological aging, changes in; collagen structure and glycosaminoglycan (GAG) / proteoglycan ratios are observed [18]. A decrease in elastin fibrils occurs with age [13,18]. The fact that the tension of the skin structure is less in geriatric patients suggests that the reliability of Spinal Mouse measurements in the frontal plane may be found to be lower in the elderly who had low BMI, parallel to the findings of our study. In a study conducted by Ripani et al. on 26 volunteers, measurements of 2 repetitions were performed with the Spinal Mouse and with X-Rays. The measurements were performed by two researchers on the same day and also on different days. However, there was no information regarding the number of days between the two measurements and which planes the measurements were performed in. The researchers conducted the statistical analysis according to the results obtained from each vertebral segment. As mentioned previously, the Spinal Mouse device provides regional results as well as the position of the vertebrae in each segment. This situation increased the number of data in their study. Considering that the total test measurement variance has the greatest impact on the alpha coefficient, the increase in the total test measure variance in the studies of Ripani et al., may have led to a different result than the other two reliability studies. Additionally, Ripani and his colleagues formed a sample group of both students and of workers in different sectors. As it is known, heterogeneous samples often lead to more variable measurements and therefore to higher reliability [19]. Ripani et al., have reported in their article that the correlation between the measurements performed by the same researcher was higher. At the end of the study, they found a high correlation between the repeated measures of the researchers. (ICC = 0.879-0.995) [20]. Similarly, in a study conducted by Guermazi et al. in 2006, intraclass ICC was found to be higher than interclass ICC [21]. In their validity and reliability study of the Spinal Mouse in 2014, Ayşe Livanelioğlu et al., found that the measurements of the Spinal Mouse device in the frontal plane were valid and reliable (ICC = 0.879 Sp0.995). Livanelioğlu et al., conducted their study, unlike ours, on AIS patients (42 females, 9 males: 14.37 ± 2.89 years). When the results of these two studies are compared, the difference in the results of the lumbar region can be attributed to the fact that the population is different. Mikko Poussa and Guy Melli investigated the spinal mobility of subjects with AIS in 1992 and found that the mobility decreased in parallel with the severity of scoliosis [22]. In the study by Livanelioğlu et al., the decrease in spinal mobility of individuals with AIS may have decreased the deviations in upright posture during measurement and may have led to a decrease in the ICC values. Livanelioğlu et al., found a high standard deviation between the measurements made by the researchers and attributed this to the attention of the researchers who performed the measurement. The ICC value that we found in our measurements supports this determination. High standard deviation between interobserver measurements and low standard deviation in intraobserver measurements emphasizes the importance of measurement standards. The experience of the investigator performing the measurements and the careful application of the measurement standards are the most important factors in order to obtain the correct results in measurements made with the Spinal Mouse device. Besides, it should be kept in mind that the error rate of the measurements made with the Spinal Mouse device is similar to the human-based error rate in x-ray devices which are accepted as the gold standard in scoliosis measurements [17,24]. Livanelioğlu et al. did not perform any measurements for the reliability of the measurements in the sagittal plane [23]. In this study, we performed

the measurements in both sagittal and frontal plane. We found that the measurements in the sagittal plane showed good reliability, unlike the frontal plane. When the devices' principles of measurement are considered, it was seen that during the measurements in the frontal plane, the device could slide laterally due to the elastic properties of the skin in subjects who were very thin and had very prominent spinal processes. However, in the sagittal plane, sliding of the device anteriorly or posteriorly was not possible. This may be the reason why measurements in the frontal plane were found to be lower than the sagittal plane measurements.

Limitation
The limitation of the study is that our sample group consisted only of female subjects.

Conclusion
In this study, the test-retest results of the thoracic and lumbar region measurements in the frontal plane were found to be moderately reliable. The test-retest results of the thoracic and lumber curves in the sagittal plane showed good reliability. In the light of these data, we believe that, if the application principles of the device are implied carefully, the Spinal Mouse device is a practical and reliable device that can be used by physiotherapists in field screening and in clinical assessment of spine problems. We suggest further studies with larger sample size.

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